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Elements for a National Master Plan for CCS – Lessons learnt

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Abstract

This paper describes the elements for a Dutch CCS Master Plan and will give concrete recommendations for countries wishing to devise a national CCS strategy based on the insights learnt from the Dutch experience. It analyzes which elements of a Master Plan are crucial and discusses the main findings from the Dutch study.

The main element of the Dutch Master plan was the "fields strategy" in which the storage potential of The Netherlands was matched with CO_2 emissions over time. This culminated in a strategy consisting of two possible routes for the two most important CCS regions in The Netherlands. It also showed that if both onshore and offshore storage potential is available, all projected emissions can be accommodated until 2050. Furthermore, the interviews with stakeholders gave very useful insights into the drivers for companies to participate in CCS as well as potential show stoppers. Lastly, the study into the costs of converting offshore oil and gas production platform for re-use as CO_2 injection platforms shed light on the cost-effective use of infrastructure and gave an indication on the effects of "mothballing" oil and gas production platforms on the costs of CO_2 injection.

Keywords: Master plan, CO_2strategy, CCS report

1. Introduction

Since the report of the IPCC and the formulation of the European Union's (EU) "20-20-20 strategy", there has been increasing attention for Carbon Capture and Storage as a means of reducing carbon dioxide emissions. Given that CCS is an industry that has large "sunk costs" and a long profitability horizon, there is an important role to play for national governments to get CCS off the ground. On the other hand, it has also become clear in recent years that it will be hard for national governments to reach required emission reduction targets without the deployment of CCS in the foreseeable future.

As suitable storage space is scarce in most countries and the initial barriers high for market parties, more and more governments opt to devise a "National Master Plan" to develop a coordinated approach towards CCS. Australia has prepared such a plan in 2009 [1], and the United Kingdom published its strategy in 2010 [2]. The Netherlands is currently working on a similar plan. It is to be expected that other countries will follow once the EU-funded demonstration projects start to materialize.

2. Goal and scope of a CCS Master Plan

The goal of a national CCS Master Plan should be to outline a detailed strategy for the long term on which companies in the CCS value chain can build their business cases. It is therefore essential that a CCS Master Plan takes a long-term view (at least 30-40 years), and that the CCS-policy of the government devising the plan is as transparent, robust and predictable as possible for this period. Also, it is very important that the role of CCS in the national emission reduction strategy - consisting of promoting energy efficiency, increasing the use of renewable energy and making the use of fossil fuels cleaner with CCS – is clearly outlined. Preferably, it should also fit in the national strategy for the use of infrastructure including the planning of use of underground reservoirs.

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The National Master Plan can contain several elements, but the core purpose is to provide insight in connecting "sources" of carbon dioxide to "sinks" over a long period of time in the most cost-effective way. It can also provide recommendations on a variety of issues such as the organization and business model, the subsidy regime, the legal regime and technical requirements. In our view, the following elements should be included in a Master Plan:

An assessment of:

- the largest (grouped) sources of CO_2 emissions in a country (the so-called "point sources")
- the expected volumes of CO_2 that can be captured in time (over a long time horizon, such as 30-40 years). Preferably, these volumes should be estimated using several scenarios
- all available storage reservoirs of sufficient size, including their availability over time
- the most cost-effective pipeline routes to connect the point sources to the sinks, taking into account the captured volumes of CO_2 in time.

In addition, a Master Plan could also contain an assessment - depending on how well-prepared a country already is for CCS - of:

- the CO_2 specifications for capture, transport and storage per CCS project (these can also be established nationally)
- the costs of re-using existing infrastructure from industries such as the oil and gas industry
- competition for use of the underground in spatial planning
- the degree of governmental participation in CCS
- the CCS business model, including subsidies, the commodity value of CCS and the optimal taxation regime
- the legal regime for CCS, taking into account both European as well as national regulation, and the possible gaps in both
- the possibilities for in- and export of CO_2, in case a country has either too much or too little storage space.

3. CCS "Master plan" study in The Netherlands

The Dutch inter-ministerial "Project Organization CCS" consulted oil and gas company Energie Beheer Nederland (EBN) and gas transport company N.V. Nederlandse Gasunie to develop 'building blocks' for a cost-effective CO_2 transport and storage strategy for the period up to 2050. Besides the regular elements of a CO_2 transport and storage strategy (connecting sources and sinks), the study comprised a broad consultation among stakeholders ranging from emitters and Exploration and Production operators to provinces and regional CCS initiatives [2]. In a substantial number of interviews, companies, government agencies and provinces were asked their opinion on a number of topics such as drivers and show stoppers for CCS, as well as financial, legal, political/regulatory, technical, organizational and societal preconditions for realizing large scale CCS (around 2030). Next to this, a study was conducted into the possibilities for converting offshore oil and gas production facilities for CO_2 injection [3]. Finally, research was done into two important areas: possible organization models for large-scale CCS and issues around the transition from gas and oil production to large-scale CCS (see figure 1).

Figure 1: Elements of the Dutch CCS study

4. Main results from the Dutch Master Plan research

In view of the high initial capital investments required, an important consideration was to devise a cost-effective transportation and storage strategy. Two emission scenarios, a baseline scenario and a "green" scenario, were used to estimate future CO_2 flows. Since most CO_2 emissions in the period between 2010 and 2050 are expected to originate in the Rotterdam, Amsterdam and North Groningen regions, the "West Netherlands" and "North Netherlands" were designated as the main CO_2 source regions. In the baseline scenario, the expected total CO_2 supply from 2015 to 2050 was estimated to be 1300 metric tonnes (Mt), 955 of which from the West Netherlands and 345 from the North Netherlands. In the green scenario, the expected CO_2 supply was approximated at 515Mt, 345 of which from the West Netherlands and 170 from the North Netherlands.

Potential storage capacity available in depleted gas and oil fields in the West Netherlands was estimated at 1160Mt offshore and 110Mt onshore, and 850Mt in the (onshore) gas fields in the North Netherlands. From modelling the available capacity in time with the projected CO_2 volumes it appeared that there should be sufficient storage capacity available in the West and North Netherlands until 2050, provided that all capacity available (onshore and offshore) can be used.

The information gathered in the interviews was used to develop several organization models in which the benefits of CCS were allocated to various players in the value chain in order to develop the most cost-effective organization model. This model was based on a chain consisting of three types of players: emitters, transportation companies and (storage) operators.

In addition, the government can take three broad roles towards CCS. In order of increasing involvement in the CCS market these are: a supervisor role, an instigator role and an active participant/owner role. It was recommended to leave as much room as possible to market parties in establishing CCS and to limit the government's role to aspects that cannot be implemented or picked up by the market. In view of the current market initiatives, the identified market shortcomings and the (still major) uncertainties, the government will have to act as instigator during the demonstration phase and the early commercial phase - in addition to setting boundary conditions (the supervisor role). The government should focus its incentive measures mainly on the capture and storage aspects of the value chain. A large-scale investment programme, associated with the participant/owner role is considered undesirable.

Lastly, the analysis of the transition from the cessation of gas production to the start of CO_2 injection focused on two main elements. On the one hand, transition from a production licence to a storage licence, on the other hand transition in the chain to large-scale CCS. Various transition scenarios and associated infrastructure configurations may cause a number of potential problems:

- If CO_2 storage capacity is not available in time this could seriously delay the implementation of CCS. As yet, there is no clear and transparent legal framework in The Netherlands for the transition from production to storage licences. This complicates formulating the intended 'fields strategy' and thus making it clear which fields will be available and when;
- On the basis of efficiency considerations (such as the existing knowledge of geological and reservoir models, costs, safety) it may be preferable to enable current gas-field operators to become CO_2 storage operators. This would facilitate transition. The EU directive, however, states that an exploration and/or storage licence may only be granted in a competitive application round. Moreover, E&P operators may not at all be interested in CO_2 storage because of the low returns in comparison to their normal business. The uncertainties with regards to the legal framework, liabilities and long term monitoring requirements provide further hurdles.
- If the incumbent operator is not interested in CO_2 storage, all (reservoir) data should be transferred to the new storage party. As yet, no transparent and enforceable legal framework exists in The Netherlands for this reservoir-data transfer, although this is essential for safe CO_2 storage.
- If the current partners in a gas production partnership agreement are not interested in participating in CO_2 storage, the licence holder is obliged to decommission the unused mining facilities. This could cause problems if the infrastructure is needed for CO_2 storage.

5. Conclusions and recommendations

From the experience of devising elements for a Dutch CCS Master Plan, it appeared that the following elements were particularly interesting for stakeholders, policy makers and researchers:

- The *interviews and feedback workshops with stakeholders* provided a holistic picture of the chances for a commercial CCS market in the Netherlands, and highlighted various major and minor issues that the industry was facing. Involvement of the stakeholders also helped in creating recommendations that are broadly supported by the entire chain. It is therefore recommended that conducting such a round of stakeholder interviews, including feedback sessions, be part of any National Master Plan.
- The *assessment of the available storage reservoirs* was impatiently awaited by the stakeholders involved in CCS. The earmarking of reservoirs for CO_2 storage demonstration projects provided much-needed clarity and provided an incentive to all parties move forward. Also, given the problems with public acceptance, local governments and emitters wanted to know which reservoirs were preferred storage locations, so that they could start a dialogue with the local population.
- The *study into the costs of converting offshore E&P infrastructure into CCS infrastructure* also proved helpful to emitters, because it provided them with an indication of the costs of converting existing infrastructure. National governments could also conduct similar research in other areas for their Master Plan, such as detailed transport costs or CO_2 standards.
- Lastly, the analysis of the *transition aspects towards large-scale CCS* shed light on several issues that have to be solved in order to realize large-scale CCS.

Also, several elements were not included in the Dutch study due to limited time and resources. It is also advised that these elements are included in a Master Plan:

- An assessment of the potential of international CO2 flows. Especially in the European context, the possibility of import or export of CO2 could help to propel CCS into a "real" business.
- Several detailed *emission scenarios* that provide insight into the most important sources of CO_2 over time. For The Netherlands, such a study was already available, but it is preferable to devise a tool to model emissions over time and integrate it with the transport and storage modelling.

A plan containing all abovementioned elements will provide the integrated approach and clarity necessary to rally all available resources behind the nascent CCS industry. Without such an approach, CCS might not be able to grow into an important tool in mitigating climate change.

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